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*NOTE: This Section's Sign-Off Record is maintained in the ESH&A Office, G40 TASF.*

## TABLE OF CONTENTS

### SECTION 4 – INDUSTRIAL HYGIENE PROGRAM

Revision Review .....	ii
Signature Page .....	iii
4.1 Hazard Communication (Right to Know) Program .....	1
4.2 Chemical Hygiene Program.....	4
4.3 Compressed / Liquefied Gases.....	6
4.4 Exposure Assessments / Medical Surveillance.....	8
4.5 Ergonomics .....	10
4.5.1 References	
4.5.2 Background	
4.5.3 Program Information	
4.5.3.1 Computer workstation Ergonomics	
4.5.3.2 Back Care and Safe Lifting	
4.5.4 Training	
4.5.5 Performance Checklists	
4.6 Respiratory Protection .....	14
4.7 Biohazardous Materials .....	16
4.8 Asbestos .....	19
4.9 Lead.....	21
4.10 Laboratory Chemical Hood Testing Program.....	23

4.11	Lasers .....	25
4.12	Radio Frequency (RF) Radiation-Generating Devices .....	29
	4.12.1 References	
	4.12.2 Background	
	4.12.3 Program Information	
	4.12.3.1 EMFs and RFR	
	4.12.3.2 Characteristics of Radio Frequency Radiation	
	4.12.3.3 Ionizing and Non-ionizing Radiation	
	4.12.4 Training	
	4.12.5 Performance Checklists	
4.13	Ultraviolet (UV) Light-Generating Devices .....	34
	4.13.1 References	
	4.13.2 Background	
	4.13.3 Program Information	
	4.13.4 Training	
	4.13.4.1 What is Ultraviolet Radiation?	
	4.13.4.2 Possible Effects of UV	
	4.13.4.3 Recommendations for Protection	
	4.13.5 Performance Checklists	
4.14	High-Powered Magnets .....	37
	4.14.1 References	
	4.14.2 Background	
	4.14.3 Program Information	
	4.14.3.1 High-Power Magnets	
	4.14.4 Training	
	4.14.5 Performance Checklists	

**REVISION / REVIEW LOG****SECTION 4 – INDUSTRIAL HYGIENE PROGRAM**

<b><u>Review Number:</u></b>	<b><u>Effective Date:</u></b>	<b><u>Contact Person:</u></b>	<b><u>Pages Affected:</u></b>	<b><u>Description of Revision:</u></b>
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1	2/13/06	Jim Withers	See Revision Description	G:\Doc&Recs\DCP\Revision Description\Manual 10200.002 Section 4 Revision 1.doc
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**SIGN-OFF RECORD**

The Environment, Safety Health and Assurance Program Manual has been reviewed and approved as documented below:

Reviewed by: \_\_\_\_\_ Date: \_\_\_\_\_  
Environment, Safety, Health & Assurance

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
Division Director, Chief Operations Officer

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
Division Director, Science and Technology

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Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
Director

*Note: Original Sign-off Record with signatures is on file with ESH&A.*

## **4.0 INDUSTRIAL HYGIENE PROGRAM**

### **4.1 HAZARD COMMUNICATION (RIGHT TO KNOW) PROGRAM**

***Applicability Statement:** This section applies ONLY to those Groups/Departments whose employees use hazardous chemicals in a non-laboratory environment (hazardous chemical use in research laboratories is specifically covered by Section 4.2, Chemical Hygiene Program).*

*This section also applies to the Environment, Safety, Health & Assurance (ESH&A) office which is charged with ensuring compliance with specific sections of the Iowa Chemical Risks Right To Know Law.*

#### **4.1.1 REFERENCES**

29 CFR 1910.1200, Hazard Communication  
347 IAC Iowa Chemical Risks Right To Know (Chapters 110, 120, 130, and 140)  
Iowa State University Worker Right-To-Know Program

#### **4.1.2 BACKGROUND**

The purpose of the Hazard Communication regulation is to ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets (MSDSs) and employee training. The key components of the Laboratory's Hazard Communication Program are an integral component of the Chemical Hygiene Program described in Section 4.2.

#### **4.1.3 PROGRAM INFORMATION**

Ames Laboratory follows the requirements listed in ISU's Worker Right To Know Manual. Information on ISU's program can be found at:

<http://www.ehs.iastate.edu/oh/wrtk.htm>

The basic elements of the Laboratory's program are: Worker or Employee Right to Know, Community Right to Know and Emergency Right to Know.

#### 4.1.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

<b>CHEMICAL HAZARD COMMUNICATION</b>		<b>#AL-137</b>
<b><i>Intended Audience:</i></b>	<i>Mandatory for personnel who work with hazardous chemicals.</i>	
<b><i>Module Format:</i></b>	<i>Classroom Instruction with Material Safety Data Sheet exercise. Estimated completion time: 2.0 hours</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>5 year retrain. Classroom or Computer-Based Training instruction.</i>	

<b>HAZARD COMMUNICATION FOR EMPLOYEES THAT DON'T USE CHEMICALS</b>		<b>#AL-150</b>
<b><i>Intended Audience:</i></b>	<i>Mandatory for all AL personnel who don't work with hazardous chemicals.</i>	
<b><i>Module Format:</i></b>	<i>Administered during General Employee Training via a handout and Material Safety Data Sheet exercise. Estimated completion time: 15 minutes</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>No retrain. Course administered during General Employee Training.</i>	

Group or activity-specific training shall be given to each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of group or activity-specific shall be conducted during the Readiness Review of activities involving the use of chemicals.

#### 4.1.5 PERFORMANCE CHECKLISTS

**Group Leader / Department Manager** shall:

- ☐ Assure that all activities have been identified, reviewed and approved by the Laboratory's Safety Review Committee via Readiness Review.
- ☐ Attend Ames Laboratory "Chemical Hazard Communication" (AL-137) training. Group Leaders receive Hazard Communication training through another course (Chemical Hygiene Training for Group Leaders) but need not attend Chemical Hazard Communication.
- ☐ Assure Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ☐ Conduct group or activity-specific hazard communication training for each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of this training shall be conducted during Readiness Review.
- ☐ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ☐ Assure that Material Safety Data Sheets (MSDSs) for all hazardous chemicals are present and accessible.

- ❑ Submit chemical inventories to ESH&A annually.
- ❑ Assure that chemical container labeling is complete and in accordance with guidelines given in the ISU Worker Right-To-Know Manual.

**Employees shall:**

- ❑ Attend Ames Laboratory “Chemical Hazard Communication”, (AL-137) training.
- ❑ Attend Ames Laboratory and / or ISU chemical safety training as indicated by Employee Training Profile.
- ❑ Receive activity / experiment-specific training prior to working with hazardous chemicals including a discussion of hazard awareness and emergency procedures.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

**Environment, Safety, Health & Assurance (ESH&A) shall:**

- ❑ Maintain hard copies of MSDSs as received and make them accessible during normal business hours.
- ❑ Maintain electronic access to Web-based sources of MSDSs and make them accessible during normal business hours.
- ❑ Assure NFPA 704 signage is present and accurate for all hazardous chemical storage areas.
- ❑ Conduct training modules and provide consultations on request that assist Laboratory personnel in the implementation of a group-specific Hazard Communication Program.
- ❑ Assure that Ames Laboratory is in compliance with the provisions of Chapters 130 (Community Right To Know) and 140 (Iowa Public Safety/Emergency Response Right To Know) of the Iowa Chemical Risks Right To Know law.

## 4.2 CHEMICAL HYGIENE PROGRAM

**Applicability Statement:** *This section applies to groups/departments whose employees use hazardous chemicals in a laboratory environment. Employees who use hazardous chemicals in a non-laboratory environment should refer to the Hazard Communication (Right to Know) Program discussed in Section 4.1.*

### 4.2.1 REFERENCES

29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories  
Iowa State University Chemical Hygiene Plan

### 4.2.2 BACKGROUND

Use of a wide variety of hazardous chemicals is critical to fulfillment of the Laboratory's research mission. Many of the Laboratory's research programs use hazardous chemicals. The Laboratory has nearly 20,000 chemicals in its inventory. The hazards associated with chemical use are significant and demand an effective management program. This section describes the mechanisms by which worker and environmental protection from deleterious effects of hazardous chemicals is assured.

### 4.2.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in ISU's Chemical Hygiene Plan. The Chemical Hygiene Plan is a written program that sets forth the policies, procedures, and practices, both for employees who work with hazardous chemicals and for those whose responsibilities include the supervision of such work. The ISU Chemical Hygiene Plan can be found at:

<http://www.ehs.iastate.edu/oh/labsafety.htm>

### 4.2.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

<b>CHEMICAL HYGIENE PLAN TRAINING FOR GROUP LEADERS #AL-127</b>	
<b><i>Intended Audience:</i></b>	<i>Mandatory for group leaders who supervise personnel who work with hazardous chemicals in a research laboratory.</i>
<b><i>Module Format:</i></b>	<i>Classroom Instruction. Estimated completion time: 2.0 hours</i>
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>No retrain. Classroom and computer-based instruction.</i>

<b>CHEMICAL HAZARD COMMUNICATION</b>		<b>#AL-137</b>
<b><i>Intended Audience:</i></b>	<i>Mandatory for personnel who work with hazardous chemicals.</i>	
<b><i>Module Format:</i></b>	<i>Classroom Instruction with Material Safety Data Sheet exercise. Estimated completion time: 2.0 hours</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>5 year retrain. Classroom or Computer-Based Training instruction.</i>	

Group / activity-specific training on chemical hygiene policies and procedures shall be given to each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of training shall be conducted during Readiness Review.

#### **4.2.5 PERFORMANCE CHECKLISTS**

**Group Leaders / Department Managers shall:**

- ❑ Assure that all research activities have been identified, reviewed and approved by the Laboratory's Safety Review Committee via Readiness Review.
- ❑ Attend "Chemical Hygiene Plan Training for Ames Laboratory Group Leaders", (AL-127) training (NOTE: Hazard Communication training is also presented in this module.)
- ❑ Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Conduct group or activity-specific chemical hygiene training for each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs or other safety information, emergency response measures and any other procedural information. Verification of this training will be conducted during Readiness Review.
- ❑ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.

**Employees shall:**

- ❑ Attend "Chemical Hazard Communication", (AL-137) training.
- ❑ Attend Ames Laboratory and/or ISU chemical safety training courses as identified on a n Employee Training Profile.
- ❑ Receive group / activity-specific chemical hygiene training prior to work that includes a discussion of chemical hazards and their mitigation.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

**Environment, Safety, Health & Assurance (ESH&A) shall:**

- ❑ Assist employees with hazard determinations including the performance of monitoring, procedure reviews, hazard control recommendations, etc.
- ❑ Conduct training modules and provide consultations, upon request, that assist Laboratory personnel in the implementation of a group-specific Chemical Hygiene Program.

### 4.3 COMPRESSED / LIQUIFIED GASES

**Applicability Statement:** *This section applies to Ames Laboratory employees who handle, store or use compressed / liquefied gases.*

#### 4.3.1 REFERENCES

ISU Document: *Cylinder Safety Guidelines*

#### 4.3.2 BACKGROUND

Compressed and liquefied gases are routinely used in laboratory and various other operations at ISU and have the potential for creating hazardous working environments. The safe use of compressed and liquefied gases are an integral part of an effective chemical management program. Because of the diversity of gases used at Ames Laboratory and the associated acute hazards, the topic is addressed separate from the Chemical Hygiene Program section.

#### 4.3.3 PROGRAM INFORMATION

Ames Laboratory's policies and procedures for the safe handling of compressed and liquefied gases are discussed in the document "Cylinder Safety Guidelines". This document is applicable to all handling of gases at Iowa State University. The basic principles of an effective management program for compressed and liquefied gases are: hazard classification, employee training, proper set-up and operation of systems as dictated by Standard Operating Procedures (SOPs), control of hazards through engineering controls /administrative controls / personnel protective equipment and emergency procedures.

Detailed programmatic information is provided via the training module listed in Section 4.3.4.

#### 4.3.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

<b>CYLINDER SAFETY</b>		<b>#AL-022</b>
<b><i>Intended Audience:</i></b>	<i>Mandatory for personnel who work with compressed gas cylinders.</i>	
<b><i>Module Format:</i></b>	<i>Classroom and/or computer-based instruction with quiz. Estimated completion time: 1.5 hours.</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>No retrain.</i>	

Group / activity-specific training on compressed gas usage shall be given to each employee prior to work that includes a discussion of specific hazards, hazard mitigation, equipment operation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of group-specific training is conducted during Readiness Reviews.

### 4.3.5 PERFORMANCE CHECKLISTS

**Group Leaders / Department Managers** shall:

- ❑ Assure that all activities that involve use of compressed/liquefied gases are identified, reviewed and approved via the Readiness Review procedure.
- ❑ Attend “Cylinder Safety”, (AL-022) training.
- ❑ Assure that Hazard Inventory / Job Task Analyses packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Conduct and document group or activity-specific training prior to work that includes a discussion of compressed and liquefied gas usage, associated hazards and their mitigation, location of MSDSs or other safety information, emergency response measures and any other procedural information.
- ❑ Assure that group or activity-specific Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.

**Employee** shall:

- ❑ Attend “Cylinder Safety”, (AL-022) training.
- ❑ Receive group / activity specific training on the safe use of compressed and liquefied gases prior to work.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

**Environment, Safety, Health & Assurance** shall:

- ❑ Provide technical assistance to Ames Laboratory employees on the safe use of gases via workplace consultations and training sessions.

## **4.4 EXPOSURE ASSESSMENTS / MEDICAL SURVEILLANCE**

*Applicability Statement: This section applies to all Ames Laboratory employees.*

### **4.4.1 REFERENCES**

Iowa State University document: *Occupational Medicine Program*

### **4.4.2 BACKGROUND**

The accurate characterization of employee exposures to chemical, physical, biological and ergonomic exposures is a fundamental component of the Industrial Hygiene Program. Accurate characterization is critical to the successful reduction or elimination of potentially harmful agents.

Medical surveillance is a vital component of any employee health and safety program and is closely linked to data gleaned from exposure assessments. Medical surveillance is one indicator that existing control measures are adequate. Occupational Medicine also prevents injury and illness by identifying potential problems and dealing with them before they have deleterious health impacts.

### **4.4.3 PROGRAM INFORMATION**

The Occupational Medicine Program provides comprehensive occupational health services to Ames Laboratory employees and is described in detail in ISU's "Occupational Medicine Manual". The main mission of the Occupational Medicine Program is compliance with applicable Federal, State and local law with emphasis on prevention, early recognition, and treatment of occupationally related illness and injury.

All Ames Laboratory employees and / or their supervisors are required to complete a Hazard Inventory and Job Task Analysis (HI/JTA) prior to their employment. Supervisory personnel are required to keep these documents complete and current for each employee throughout their tenure at Ames Laboratory. Successful completion of these documents assures that the employee's hazards and activities will be reviewed as a part of the Industrial Hygiene and Occupational Medicine Programs.

### **4.4.4 TRAINING**

There is no specific training module associated with this sub-section. All employees are introduced to the Hazard Inventory and Job Task Analysis (HI/JTA) packet in "General Employee Training", (AL-001) which is discussed in Section 3 (Training) of this manual.

#### **4.4.5 PERFORMANCE CHECKLISTS**

**Group Leaders / Department Managers shall:**

- ☐ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ☐ Assure that Hazard Inventory / Job Task Analysis packets for all personnel are complete and current.
- ☐ Review employee Hazard Inventories / Job Task Analyses on an annual basis and / or whenever activities change and update if necessary.
- ☐ Assure that employees receive required medical examinations per notification by Occupational Medicine.
- ☐ Assure that employees report to Occupational Medicine with work-related injuries.

**Employees shall:**

- ☐ Complete Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) in collaboration with supervisor at time of initial employment and whenever job functions and associated hazards change.
- ☐ Receive mandatory medical examinations as notified by Occupational Medicine.
- ☐ Report to Occupational Medicine with work-related injuries and / or illnesses.

**Occupational Medicine shall:**

- ☐ Conduct mandatory medical surveillance examinations.
- ☐ Assure that employees receive medical surveillance examinations.
- ☐ Identify potential or actual health effects resulting from work site exposures.
- ☐ Communicate information regarding workplace health hazards to management, workers, and those responsible for mitigating work site hazards.

**Environment, Safety, Health & Assurance (ESH&A) shall:**

- ☐ Review site survey information and perform monitoring, as indicated, to characterize worker exposures.
- ☐ Report exposure monitoring results to employees and Occupational Medicine as indicated.

## 4.5      **ERGONOMICS**

**Applicability Statement:** *This section applies to groups/departments whose activities involve repetitive motions that may lead to cumulative trauma disorders. Examples include frequent use of computer keyboards and frequent lifting.*

### 4.5.1    **REFERENCES**

Ames Laboratory document: “Ergonomics: Guidance for the Prevention of Ergonomic Stresses”

### 4.5.2    **BACKGROUND**

Working Americans spend about 2000 hours a year in the workplace. Not surprisingly, all of these hours can take a toll on an employee’s eyes, back, hands and neck. Poorly designed working environments can result in momentary pain or long-term injury and lead to reduced efficiency and production, loss of income, increased medical claims and permanent disability. Ergonomics is the art and science of designing the workplace to fit the worker. The primary goal of ergonomics is the prevention of musculoskeletal injuries caused by poor lifting techniques and/or repetitive motions associated with job tasks.

Occupational Medicine and Ames Laboratory’s Environment, Safety, Health & Assurance (ESH&A) are available to assist employees in the resolution of any potential ergonomic problems. The following is provided as guidance information on ergonomics.

### 4.5.3    **PROGRAM INFORMATION**

#### 4.5.3.1   **Computer Workstation Ergonomics**

Perhaps the most commonly discussed workplace injury of the last decade has been carpal tunnel syndrome and related maladies of the wrist and hand. Carpal tunnel syndrome is a part of a group of illnesses known as cumulative trauma disorders (CTDs).

Computer data entry and computer workstations -- including the components of monitors, keyboards, chairs, and so on -- present a unique set of ergonomic situations that may need evaluation and correction. The following guidelines can help employees work more comfortably and effectively at a computer workstation:

#### Chair:

- Adjust the height of the chair's seat so thighs are horizontal, feet rest flat on the floor, and arms and hands are comfortably positioned at the keyboard.
- If the chair is too high, use a footrest to take pressure off the back of the thighs.
- Armrests, seat back, and chair height should be adjustable.
- Adjust the back rest so that it supports and fits the curvature of the lower back.
- Seat cushions should be firm, not soft.
- General rule of thumb on chair casters: Use hard (plastic) casters on carpeted surfaces and soft (rubber) casters on tile, concrete or wood surfaces.
- If possible, arrange to sit in a demo model for up to a week prior to purchase.

Display:

- Position the screen to minimize glare and reflections for overhead lights, windows, and other light sources. An anti-glare filter screen can be used.
- Adjust the display so the top of the screen is slightly below eye level when sitting at the keyboard.
- Set the contrast or brightness of the screen to a comfortable level.

Lighting:

- Adjust drapes/blinds to reduce glare.
- Adjust desk lamp or task light to avoid reflections on the screen.
- Reduce overhead lighting.

Document Holder:

- Position document holder close to screen and at the same level and distance from the eye to avoid constant changes of focus.
- Rotate position of document holder to opposite side of screen periodically.

General Information:

- Change position, stand up or stretch whenever you start to feel tired.
- Use a soft touch on the keyboard, keeping hands and fingers relaxed, and wrists and body in neutral positions.
- If the keyboard is too high, install an adjustable height keyboard tray; as a temporary measure, the seat height can be raised as long as the feet are supported by a footrest.
- The head should be straight and balanced over the spine while looking at the screen.
- Elbows should be bent at 90 degrees when hands are at the keyboard; wrists should be in a neutral position; utilize wrist rests at the edge of the keyboard for support.
- Consult Occupational Medicine and/or Industrial Hygiene personnel if you have headaches, muscle/joint pain, tingling in the hands/fingers or other symptoms that you suspect may be related to computer work.

#### **4.5.3.2 Back Care and Safe Lifting**

Statistics show that 80% of Americans suffer from some type of back pain during their lifetime. The costs of back injuries are significant to employers in terms of lost work time and Worker's Compensation payments, while also impacting the employees' general quality of life. The principles of safe lifting are effective in reducing back injuries and are applicable to a variety of occupations. Ames Laboratory offers training on how to prevent sprains and strains (see Training section). Whenever you are lifting something, keep the following points in mind:

- Plan each lift before you start, including the path you will be traveling.
- Size up the load. Can you carry it or do you need help?
- Get any needed equipment to help transport the load -- including a hand truck, pushcart, forklift or wheelbarrow.
- Wear snug-fitting gloves to help you grip the load you are about to lift.
- Do simple stretching and bending exercises before you lift.
- Bend your knees and keep your back as straight as possible. Tighten stomach muscles before lifting.
- Crouch, don't squat.

- Get close to the load, and hug it to your body before lifting.
- Keep your head, shoulders, and hips in a straight line. Maintain the lumbar curve of the lower back.
- Reverse the steps for lifting when setting the load down -- keeping the pressure on your arms and legs, not on your back.
- Prevent back strains by not bending at the waist to pick up any object.
- Consult your supervisor about redesigning a work task to avoid unsafe lifting.

#### 4.5.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

<b>ERGONOMICS</b>		<b>ISU# INH08</b>
<b><i>Intended Audience:</i></b>	<i>This workshop will address office ergonomic issues, focusing on types and prevention of repetitive motion injury, as well as proper workstation configuration and adjustment. A segment on low back pain is included that addresses proper lifting techniques and stretching exercises. NOTE: Attendance is not limited to office personnel. The core course material can benefit any employee where ergonomic problems are an issue. Anyone wishing to learn more about the prevention of repetitive motion injury should consider attending this course.</i>	
<b><i>Module Format:</i></b>	<i>Classroom Instruction. Estimated completion time: 3.0 hours.</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>No retrain.</i>	

<b>SPRAINS &amp; STRAINS PREVENTION TRAINING</b>		<b>AL-183</b>
<b><i>Intended Audience:</i></b>	<i>Provides employees with information on sprains and strains, contributing factors, body postures, engineering controls and safe lifting practices. This course is required for all employees who lift, push/pull objects that weigh more than 40 pounds or who frequently lift, push/pull objects that weigh 20-40 pounds.</i>	
<b><i>Module Format:</i></b>	<i>Computer-based instruction. Estimated completion time: 0.5 hours.</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>No retrain.</i>	

#### 4.5.5 PERFORMANCE CHECKLISTS

**Group Leader / Department Manager** shall:

- ☐ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.

- ❑ Review ergonomic training course offerings as listed on the ISU and / or Ames Laboratory training schedules and attend, as appropriate.
- ❑ Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Assess group activities for repetitive motions including use of computers and materials handling (lifting, etc.).
- ❑ Request ergonomic consultations from Occupational Medicine and Industrial Hygiene personnel, as needed.
- ❑ Encourage group members to attend ergonomic training courses as listed on the ISU and / or Ames Laboratory training schedules.

**Employee shall:**

- ❑ Attend ISU and / or ergonomics courses as indicated by activities and supervisor.
- ❑ Assess work activities for repetitive motions including use of computers and materials handling (lifting, etc.).
- ❑ Request ergonomic consultations from Occupational Medicine and Industrial Hygiene personnel.

**Environment, Safety, Health & Assurance shall:**

- ❑ Notify employees of available training opportunities via monthly training newsletter.
- ❑ Provide ergonomic consultations to employees upon request, in conjunction with Occupational Medicine personnel.

## 4.6 RESPIRATORY PROTECTION

**Applicability Statement:** *This section applies to employees who use respiratory protection in the workplace.*

### 4.6.1 REFERENCES

29 CFR 1910.134, Respiratory Protection

### 4.6.2 BACKGROUND

Hazards can be effectively controlled through engineering, administrative and / or personal protective equipment controls. Engineering controls contain hazards at the source and are considered the most effective. Administrative controls include standard operating procedures and, when followed, effectively reduce or eliminate hazards. The last form of control is personal protective equipment and includes gloves, hard hats, steel-toed shoes and respirators.

ESH&A administers the Ames Laboratory Respiratory Protection Program.

### 4.6.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in the ISU document “Respiratory Protection Program”. Respirator users are identified by the Occupational Medicine database or by employees contacting ESH&A. Hazard evaluations are conducted to evaluate the need for any type of respiratory protection including the use of disposable dust masks. Fit-testing and training are conducted initially and annually thereafter.

Detailed programmatic information is discussed via the training module listed in Section 4.6.4.

### 4.6.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

<b>RESPIRATOR FIT-TESTING &amp; TRAINING</b>		<b>#AL-011</b>
<b><i>Intended Audience:</i></b>	<i>Mandatory for employees who use any type of tight-fitting respirators.</i>	
<b><i>Module Format:</i></b>	<i>Laboratory instruction with quiz. Estimated completion time: 1.0 hour.</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>Annual retrain. Written information and quiz.</i>	

### 4.6.5 PERFORMANCE CHECKLISTS

**Group Leaders / Department Managers** shall:

- ☐ Assure all activities are identified, reviewed and approved via the Readiness Review procedure.
- ☐ Attend respirator fit-testing and training prior to using any tight-fitting respirator.
- ☐ Assure Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires

(TNQs) are complete and current for each employee.

**Employees shall:**

- ❑ Attend respirator fit-testing and training prior to using any tight-fitting respirator.
- ❑ Notify ESH&A of any usage of single-use, disposable dust masks.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

**Environment, Safety, Health & Assurance shall:**

- ❑ Administer the ISU Respiratory Protection Program that includes conducting training, notifying employees of the need for refresher training, recordkeeping, etc.
- ❑ Provide exposure evaluations, upon request, that will assist employees in determining the need for respiratory protection.

**Occupational Medicine shall:**

- ❑ Administer medical surveillance to respirator users, as required.

## 4.7 BIOHAZARDOUS MATERIALS

**Applicability Statement:** *This section applies to groups/departments whose employees work with or may be exposed to biohazardous materials as part of their job responsibilities.*

### 4.7.1 REFERENCES

ISU Biosafety Manual

### 4.7.2 BACKGROUND

Research with biohazardous materials is increasing at Ames Laboratory. The ISU Biosafety Manual defines biohazardous materials as follows:

“Biohazardous materials are those materials of biological origin that could potentially cause harm to humans, domestic or wild animals, or plants. Examples include recombinant DNA; transgenic animals or plants; human, animal or plant pathogens; biological toxins (such as tetanus toxin); human blood and certain human body fluids; and human or primate cell cultures.”

Included in this definition are bloodborne pathogens as defined by OSHA’s Bloodborne Pathogen regulation. Traditionally, occupational exposures to potentially infectious materials has been the biohazardous material of primary concern at Ames Laboratory. A bloodborne pathogen is defined as any pathogenic microorganism present in human blood that can cause disease in humans. These pathogens include the Human Immunodeficiency Virus (HIV) or AIDS virus, Hepatitis B virus (HBV) and other bloodborne infectious agents. The information in this section describes the mechanisms by which biohazardous materials are evaluated and controlled.

### 4.7.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in ISU’s Biosafety Manual. The Manual along with the information in this section constitute the Laboratory’s written program. Additional programmatic information is provided via the modules listed in section 4.7.4.

The three areas of concern when using biohazardous materials are as follows:

**Licensing:** Does the Group Leader have a signed agreement with the vendor of the material that states the details of their use and disposition?

**Safety:** Are the materials pathogenic to humans, animals or plants? Is so, has the project received Institutional Biosafety Committee approval? Have employees received Biohazardous Materials and Bloodborne Pathogen training, as appropriate?

**Confidentiality:** Are there any unique identifiers associated with the samples? If so, has the project received Institutional Review Board approval?

The primary mechanism by which work with biohazardous materials is evaluated is Readiness Review (described in Section 1). Group Leaders should consult with ESH&A on the requirements for work with biohazardous materials early in the planning of research and prior to any research being conducted as many biohazardous materials have strict regulatory requirements for shipment, use and disposition.

#### 4.7.4 TRAINING

The following institutional training modules provide detailed information to the student on biohazardous materials:

<b>BIOHAZARDOUS MATERIALS: AN INTRODUCTION (AL 0XX)</b>	
<b><i>Intended Audience:</i></b>	<i>Mandatory for personnel who work with or supervise work with biohazardous materials as defined previously as a part of their job.</i>
<b><i>Module Format:</i></b>	<i>Web-based training. Estimated completion time: 1.0 hour.</i>
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>No retrain.</i>

<b>BLOODBORNE PATHOGEN EXPOSURE CONTROL PLAN TRAINING #AL035</b>	
<b><i>Intended Audience:</i></b>	<i>Mandatory for personnel who work with or supervise employees who work with potentially infectious materials as a part of their job.</i>
<b><i>Module Format:</i></b>	<i>Classroom or web-based instruction. Estimated completion time: 1.5 hours.</i>
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>Annual retrain.</i>

In addition to the institutional modules above, group / activity-specific training shall be given to each employee prior to work that includes a discussion of hazards associated with biohazardous materials in use, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of group-specific training shall be conducted during Readiness Reviews.

#### 4.7.5 PERFORMANCE CHECKLISTS

**Group Leaders / Department Managers** shall:

- ❑ Maintain an inventory of all biohazardous materials (see definition above).
- ❑ Assure that all research activities involving biohazardous materials are identified, reviewed and approved via the Readiness Review procedure. This approval will include verification of all ISU committee approvals including the Institutional Biosafety Committee and Institutional Review Board.
- ❑ Complete the “Biohazardous Materials: An Introduction” course and, if appropriate the “Bloodborne Pathogen Exposure Control Plan Training” course.
- ❑ Assure Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current and reflect work with biohazardous materials.

- ❑ Conduct and document group or activity-specific training prior to work that includes a discussion of the hazards of biohazardous materials, hazard mitigation, location of MSDSs or other safety information, emergency response measures and any other procedural information.
- ❑ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ❑ Consult Environment, Safety, Health and Assurance with any questions related to biohazardous materials.

**Employees shall:**

- ❑ Attend “Biohazardous Materials: An Introduction” and “Bloodborne Pathogen Exposure Control Plan Training” as appropriate.
- ❑ Receive group or activity-specific training prior to work that includes a discussion of the hazards associated with the potentially infectious materials being used.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

**Environment, Safety, Health & Assurance shall:**

- ❑ Maintain a facility-wide inventory of biohazardous materials and submit an annual report to the Ames Site Office.
- ❑ Facilitate completion of Readiness Review and any applicable ISU committee approvals.
- ❑ Assist employees with hazard determinations including the performance of monitoring, procedure reviews, hazard control recommendations, etc.
- ❑ Conduct training module and provide consultations, upon request, that assist Laboratory personnel in the implementation of requirements of this section.

## 4.8 ASBESTOS

**Applicability Statement:** *This section applies to groups/department whose employees remediate asbestos as certified asbestos abatement workers.*

### 4.8.1 REFERENCES

29 CFR 1910.1001, Asbestos  
ISU Asbestos Management Program Manual

### 4.8.2 BACKGROUND

Health effects from asbestos exposure include asbestosis and mesothelioma. Asbestos-containing materials are prevalent throughout Ames Laboratory buildings and periodically require removal or encapsulation. This section of the Program Manual describes how to implement the program that ensures all affected employees are protected from occupational exposure to asbestos.

### 4.8.3 PROGRAM INFORMATION

The purpose of the Asbestos Management Program is to assure the safe handling of asbestos during treatment, removal and disposal. The program consists of comprehensive safe operating practices (which includes guidelines for all scales of asbestos projects).

### 4.8.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

<b>SUPERVISOR / WORKER TRAINING</b>		<b>#AL-159</b>
<b><i>Intended Audience:</i></b>	<i>This is required for supervisors and workers who conduct asbestos abatement work.</i>	
<b><i>Module Format:</i></b>	<i>Classroom Instruction. Estimated completion time: 4.0 days. Course conducted by off-site vendor.</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>Annual retrain; 8-hour refresher.</i>	

<b>ASBESTOS AWARENESS TRAINING</b>		<b>#AL-125</b>
<b><i>Intended Audience:</i></b>	<i>This is required for all employees who may potentially encounter asbestos in the course of their normal duties but do not handle it directly.</i>	
<b><i>Module Format:</i></b>	<i>Classroom instruction. Estimated completion time: 1.0 day.</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>Annual retrain.</i>	

#### **4.8.5 PERFORMANCE CHECKLISTS**

**Group Leaders / Department Managers shall:**

- ❑ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ❑ Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Attend initial "Supervisor/Worker Training" and receive annual refresher training.
- ❑ Assure that employees are performing work in accordance with policies and procedures that mitigate hazards associated with asbestos.

**Employees shall:**

- ❑ Attend initial "Supervisor/Worker Training" and receive annual refresher training.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

**Environment, Safety, Health & Assurance shall:**

- ❑ Provide consultations, upon request, to determine potential for asbestos exposure.
- ❑ Collaborate with Facilities Services on work activities, bulk samples, training, waste disposal, state notifications and other programmatic elements.

**Facilities Services shall:**

- ❑ Perform asbestos remediation work in accordance with established policies and procedures.

## 4.9 LEAD

**Applicability Statement:** *This section applies to groups/departments whose activities involve the use, maintenance, and disturbance of lead-containing materials. At Ames Laboratory this primarily applies to Facilities Services. Lead use in a research activity is covered by the Chemical Hygiene Program section.*

### 4.9.1 REFERENCES

29 CFR 1910.1025, Lead

### 4.9.2 BACKGROUND

Health effects from lead exposure continue to be a concern in the workplace and in the home. Since the ban on lead in gasoline, lead levels detected in areas near roadway have decreased dramatically; however, lead based paint used in buildings and housing prior to 1980 continue to serve as significant sources of exposure.

### 4.9.3 PROGRAM INFORMATION

The Laboratory follows the policies and procedures detailed in the ISU document “Guidelines for Working with Lead-Containing Materials”. The information in this document applies to the use, maintenance and/or disturbance of lead-containing materials at ISU. The purpose of the document is to assure that lead and lead-containing materials are properly maintained and handled.

**Laboratory use** of lead is covered in the Chemical Hygiene Program, Section 4.2.

Detailed programmatic information is provided via the training modules listed in Section 4.9.4.

### 4.9.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

<b>LEAD AWARENESS TRAINING</b>		<b>ISU #INH06</b>
<b>Intended Audience:</b>	<i>Employees and their supervisors who may sand, scrape, abrade or otherwise disturb lead containing building materials during construction, renovation or maintenance activities.</i>	
<b>Module Format:</b>	<i>Classroom instruction. Estimated completion time: 2.0 hours.</i>	
<b>Associated Retrain Period &amp; Format:</b>	<i>No retrain.</i>	

#### **4.9.5 PERFORMANCE CHECKLISTS**

**Group Leaders / Department Managers shall:**

- ❑ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ❑ Attend ISU "Lead Awareness Training", (INH06).
- ❑ Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Assure that all work conducted by employees is done in accordance with the provisions of the ISU document "Guidelines for Working with Lead-Containing Materials".

**Employees shall:**

- ❑ Attend ISU "Lead Awareness Training", (INH06).
- ❑ Conduct work in accordance with the provisions of the ISU document "Guidelines for Working with Lead-Containing Materials".

**Environment, Safety, Health & Assurance (ESH&A) shall:**

- ❑ Assist employees with hazard determinations including the performance of monitoring, procedure reviews, hazard control recommendations, etc.
- ❑ Provide consultations, upon request, that assist Laboratory personnel in the implementation of a group-specific program that assures the safe handling and use of lead and lead-containing materials.

## **4.10 LABORATORY CHEMICAL HOOD TESTING PROGRAM**

**Applicability Statement:** *This section applies to groups/departments whose activities involve the testing and maintenance of chemical hoods. At Ames Laboratory this primarily applies to Environment, Safety, Health & Assurance and Facilities Services.*

### **4.10.1 REFERENCES**

29 CFR 1910.1450, Occupational Exposures to Hazardous Chemicals in Laboratories

### **4.10.2 BACKGROUND**

Laboratory chemical hoods are the primary engineering control utilized at Ames Laboratory for chemical safety. When properly used, chemical hoods are effective in reducing or eliminating worker exposures to chemical vapors produced as a result of work with hazardous chemicals. Regular testing and certification of chemical hoods is essential to ensuring adequate performance. This section describes the protocol for annual testing of chemical hoods at Ames Laboratory.

### **4.10.3 PROGRAM INFORMATION**

The Environment, Safety, Health & Assurance office tests chemical hoods on an annual basis. Testing guidelines are gleaned from the ISU Chemical Hygiene Plan. Industrial Hygiene personnel evaluate current usage of the chemical hood and make a determination of the adequacy of the face velocity rating. ESH&A personnel consult with Facilities Services when face velocity adjustments are necessary.

### **4.10.4 TRAINING**

There is no institutional training module associated with this section of the Environment, Safety, Health & Assurance Program Manual.

### **4.10.5 PERFORMANCE CHECKLISTS**

**Group Leaders / Department Managers** shall:

- ☐ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ☐ Assure chemical hoods are used correctly and in accordance with the guidelines in the ISU Chemical Hygiene Plan (see Chemical Hygiene Program, Section 4.2).
- ☐ Report chemical hood performance deficiencies to ESH&A for correction.

**Employees** shall:

- ☐ Use chemical hoods in accordance with guidelines in the ISU Chemical Hygiene Plan (see Chemical Hygiene Program, Section 4.2).
- ☐ Report chemical hood performance deficiencies to supervisor.

**Environment, Safety, Health & Assurance (ESH&A) shall:**

- ❑ Test chemical hood face velocities on an annual basis and request any modifications from Facilities Services.
- ❑ Provide consultations, upon request, to Laboratory personnel on the use of chemical hoods.

**Facilities Services shall:**

- ❑ Modify chemical hoods as requested by ESH&A.

## 4.11 LASERS

*Applicability Statement: This section applies to Groups/Departments that use lasers.*

### 4.11.1 REFERENCES

Iowa State University *Laser Safety Manual*

### 4.11.2 BACKGROUND

Use of laser systems is an important part of research conducted at Ames Laboratory. The hazards associated with lasers are significant and demand an effective management program. This section describes the basic elements of the Laboratory's Laser Safety Program.

### 4.11.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in Iowa State University's *Laser Safety Manual*. This document can be viewed at:

<http://www.ehs.iastate.edu/publications/manuals/laser.pdf>

The basic elements of the ISU document are: Responsibilities, Basic Laser Characteristics, Classes of Lasers, Beam Hazards, Associated Hazards, Laser Safety Practices, Requirements for Laser Operations, Personal Protective Equipment, Warning Labels & Signs, Laser Safety Standard Operating Procedures, Laser Safety Training, Medical Surveillance & Exposure Incidents. The following is an abbreviated summary of each of these elements. The reader is referred to the full text of the Manual for a complete version of this information.

#### 4.11.3.1 Responsibilities

**Environment, Safety, Health & Assurance (ESH&A)** is responsible for maintaining an inventory of all Class 3b & 4 lasers, reviewing procedures, providing technical assistance, verifying training records and facilitating the completion of training. The Laboratory's Laser Safety Officer (LSO) (Jim Withers) is a member of the ESH&A office.

**Laser user** is responsible for meeting all applicable requirements including training and medical surveillance before operating a 3b or 4 laser and following safe work practices when working with lasers including the use of appropriate PPE.

**Group Leader** is responsible for ensuring that laser users are authorized, trained and medically-approved to use lasers and that an approved Standard Operating Procedure (SOP) is being followed that includes the use of appropriate Personal Protective Equipment (PPE). Work practices are regularly observed and any deficiencies corrected.

#### **4.11.3.2 Basic Laser Characteristics**

Laser radiation transmits energy. This energy is deposited in the form of heat. The principle target organs of concern are the eyes and skin. The degree of hazard for laser radiation is dependent on the wavelength, the intensity or power and the duration of exposure.

#### **4.11.3.2 Classes of Lasers**

Class 1 Laser – low power, completely enclosed, exempt from any control measures.

Class 2 Laser – power <1 milliwatt, blink reflex of human eye is usually adequate control, training and medical surveillance not required.

Class 3a Laser – power levels of 1-5 milliwatts, significant hazards when viewed through optical instruments, training and medical surveillance not required.

Class 3b Laser – power levels of 5-500 milliwatts, hazardous upon direct viewing or diffuse/specular reflection, training and medical surveillance required.

Class 4 Laser – power levels >500 milliwatts, hazardous upon direct viewing or diffuse/specular reflection, potential for fire hazards, training and medical surveillance required.

#### **4.11.3.3 Beam Hazards**

The nature of laser beam damage is dependent on the wavelength of light, energy of the beam, divergence and exposure duration. The primary organ of concern is the eye with heating of the tissue being a principle adverse effect. The retina is the part of the eye of particular concern as this tissue does not regenerate.

#### **4.11.3.4 Associated Hazards**

There are additional hazards associated with lasers. Electrical hazards are a concern due the high-voltages required to power lasers. Chemicals such as dyes are sometimes used with laser and can be toxic. Collateral radiation can be given off as a “by-product” of the primary laser and can include forms of ionizing radiation. A fire hazard can be created by any combustible material that is exposed to high beam irradiance for more than a few seconds. Explosion hazards exist with high-pressure lamps, filament lamps and capacitors.

#### **4.11.3.5 Laser Safety Practices**

Common work area safety practices include: isolating the laser from uninformed or curious by standers, setting up the laser operation above or below normal eye level, enclosing the beam when practical, reducing the potential for reflections and covering windows to hallways. Laser use safety practices include: avoiding direct beam observations, keeping unauthorized personnel out of laser labs and the use of appropriate Personal Protective Equipment (PPE).

#### **4.11.3.6 Requirements for Laser Operations**

General requirements for laser operations include: using lasers for their intended purpose, assuring that all 3b and 4 lasers have been registered and reviewed by the Laser Safety Officer, assuring that all 3b and 4 laser operators have received training, a medical exam and are using

appropriate PPE. All lasers require a protective housing. Interlock systems must be in place for all Class 4 systems used at Ames Laboratory. Laser control areas are to be designated for use of Class 3b and 4 systems. Control areas must be appropriately signed and designated for authorized personnel only.

#### **4.11.3.7 Personal Protective Equipment**

When engineering and administrative controls are not feasible, the use of appropriate PPE is required. Eye protection must be suitable for the laser in use. Occasionally, protective clothing such as gloves and forearm covers might be required to avoid damage to the skin.

#### **4.11.3.8 Warning Labels and Signs**

Lasers and laser systems require appropriate signage. The verbiage on signage is specific to the class of laser. ANSI Z136.1 requirements will be followed for all laser signage.

#### **4.11.3.9 Laser Safety Standard Operating Procedures**

A written SOP is required for laser Class 3b and 4 laser operations. SOPs will reside in the Readiness Review file for the activity.

#### **4.11.3.10 Training**

All Class 3b and 4 laser operators are required to take the Ames Laboratory laser safety training module. Additionally, 5-year refresher training is required for all Class 3b & 4 laser users.

#### **4.11.3.11 Medical Surveillance & Exposure Incidents**

Baseline eye exams are required for all Class 3b & 4 laser users. Additional medical exams may be indicated in the event of an exposure. Employees are required to report all laser exposure events.

### **4.12 TRAINING**

<b>LASER SAFETY TRAINING</b>		<b>#AL-070</b>
<b><i>Intended Audience:</i></b>	<i>Mandatory for all workers who work with Class 3b and 4 lasers.</i>	
<b><i>Module Format:</i></b>	<i>Module consists of a video; computer based training. The participant shall also complete a base line eye exam. Estimated completion time: 1.5 hours.</i>	
<b><i>Associated Retrain Period &amp; Format:</i></b>	<i>3 year retrain via a Web-based course.</i>	

Group / activity-specific training shall be given to each employee prior to work that includes a discussion of laser hazards and hazards associated with the laser, such as laser dyes, electrical hazards, chemical concerns, etc. In addition, the group or activity training shall review emergency response measures and any other procedural information.

#### 4.11.5 PERFORMANCE CHECKLISTS

**Group Leader / Department Manager shall:**

- ☐ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ☐ Attend Ames Laboratory "Laser Safety" training, (AL-070) if working with Class 3b and 4 lasers and receive baseline and exit eye exams.
- ☐ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ☐ Conduct and document group/activity-specific laser training for each employee prior to work.
- ☐ Conduct periodic observations of work to ensure that safe work practices are being conducted.
- ☐ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ☐ Assure that laser laboratory is set up in accordance with the ISU Laser Safety Manual.

**Employees shall:**

- ☐ Attend Ames Laboratory "Laser Safety" training, (AL-070) if working with Class 3b and 4 lasers and receive baseline and exit eye exams.
- ☐ Receive activity or experiment-specific training prior to working with lasers.
- ☐ Perform work in accordance with group Standard Operating Procedures (SOPs) including the use of appropriate PPE.

**Environment, Safety, Health and Assurance (ESH&A) shall:**

- ☐ Perform Laser Hazard Assessments initially and review on an annual basis. The annual review will include observation of work. LHAs may also be done if significant changes are made in the set up of a laser system.
- ☐ Advise Laboratory personnel on the safe use of lasers and assist with group-specific implementation.

**Occupational Medicine shall:**

- ☐ Facilitate the completion of laser eye exams for Laboratory personnel.

## 4.12 RADIO FREQUENCY (RF) RADIATION-GENERATING DEVICES

**Applicability Statement:** *This section applies to Groups/Departments that use RF radiation-generating devices.*

### 4.12.1 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH) Handbook “Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices”

ANSI/IEEE Standard C95.1 Safe Levels With Respect to Human Exposure to RF Radiation, 3kHz to 300 GHz

### 4.12.2 BACKGROUND

Use of devices that generate RF radiation is an important part of several of the Laboratory’s research programs. The hazards associated with RF radiation are potentially significant and demand an effective management program. This section describes the health physics protection mechanisms designed to ensure worker protection from RF radiation.

### 4.12.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in American Conference of Governmental Industrial Hygienists (ACGIH) Handbook entitled “Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices” and ANSI/IEEE Standard C95.1, “Safe Levels With Respect to Human Exposure to RF Radiation, 3kHz to 300 GHz.” These documents, along with the information contained in this section of the Ames Laboratory ESH&A Program Manual and the training information presented below constitute the Laboratory’s written program. The basic elements of the Laboratory’s program are: ESH&A surveys of RF systems, Readiness Review procedures and the group-specific safety training for laser users.

#### 4.12.3.1 EMFs and RFR

Electromagnetic energy exists in a variety of forms: television and radio waves, heat lamp radiation, microwaves, light from the sun and other sources, and electrical currents passing through wires. Electromagnetic energy occurs in two forms. When current passes through electrical wires, electromagnetic energy is created as fields around the wires. These fields, called electromagnetic fields (EMFs), have both an electric and magnetic component. Electromagnetic energy can also move from one point to another by waves propagated through space, such as visible light and radio waves. As defined by the Institute of Electrical and Electronics Engineers (IEEE), radiofrequency radiation (RFR) are waves moving through space which lie in the frequency range of 3 kHz to 300 GHz. (Figure 4.12-1 below)

Frequency Range (Hz)	Wavelength Range	Type of Radiation
10E20-10E24	10E-12 - 10E-16 m	Gamma-rays
10E17 - 10E20	1 nm - 1 pm	x-rays
10E15 - 10E17	400 - 1 nm	Ultraviolet light
4.3 - 7.5x10E14	700-400 nm	visible light
10E12 - 10E14	2.5 um - 700 nm	Infrared light
10E8 - 10E12	1 mm - 2.5 um	Microwaves
10E0 - 10E8	10e8 - 1 m	radio waves

Figure 4.12-1 – The Electromagnetic Spectrum

Health effects caused by the magnetic field portion of EMFs have been a subject of intense debate. Beginning in 1979, researchers began to suggest a link between EMFs and leukemia. Some feel that continuing research since 1979 has confirmed the correlation between EMFs and leukemia. However, the National Academy of Science report of October 31, 1996, "Possible Health Effects of Exposure to Residential Electric and Magnetic Fields," "concluded that no conclusive evidence exists which shows that EMFs play a role in the development of cancer."

#### **4.12.3.2 Characteristics of Radio Frequency Radiation**

Transmitted electromagnetic waves travel at the speed of light. RFR radiates outward from its transmission source in energy packets that combine the characteristics of waves and particles. Once generated, these waves of energy travel from their transmitter through space, where they are reflected from, refracted around, or absorbed by, their intended receivers or by any object in its path. The absorbed energy is the source of health-related concerns.

Based on the characteristics of the wave and the material that absorbs it, the absorbed energy might affect the absorbing material in a number of ways. The absorbed energy could cause a resonating electrical effect in some conducting materials, as occurs in receiving antennas in radio and TV systems. It could be re-emitted as electromagnetic energy such as fluorescence in visible or ultraviolet light. As higher energy forms it could interact with chemical bonds in complex molecules resulting in changes to the nature of the molecule. This interaction is the basis for sunburns caused by ultraviolet light, and "radiation" burns caused by gamma ray irradiation. Some electromagnetic waves, like X-rays and certain forms of gamma radiation, may pass completely through some materials without being absorbed. (Each of these types of electromagnetic waves are in frequency ranges much higher than RFR.) Most commonly, electromagnetic energy is simply absorbed by materials and converted into heat energy. ESH&A will measure RFR levels and determine if they exceed the TLVs. If they do, shielding in the form of some type of wire mesh, around the RFR source has been found to be very effective in reducing the RFR emission rate. Care must be taken not to allow the mesh to come in contact with surfaces that would be effected by heat energy, since the mesh absorbs the RFR, which is converted to heat in the mesh.

Electromagnetic waves can be characterized by three attributes - frequency, amplitude and intensity. Frequency is the rate at which electromagnetic waves are generated or pass a fixed point. Frequency determines wavelength, with longer waves having lower frequency and shorter waves a higher frequency. Frequency is measured in cycles per second units, called hertz (Hz) (60 Hz = 60 cycles/second).

Amplitude is a relative measure of a wave's energy level. Waves at the same frequency with higher amplitude deliver more energy. Waves with the same amplitude at higher frequencies carry more energy. Two waves with the same frequency can have different amplitudes based upon how much energy is put into each wave's production.

Intensity, or power density, is the rate at which energy is transmitted through a given area (measured in milliwatts per square centimeter - mW/cm<sup>2</sup>). Intensity is therefore a measure of a wave's total energy after traveling a given distance from its source. A wave radiating away from its source has its energy spread more thinly the farther it travels. As a radio wave radiates outward, its energy is dispersed over an ever-increasing area resulting in an inverse-square

principle. Every time the distance from an emitting source is doubled, the area covered increases by a factor of four and the power density decreases by a factor of four. A wave registering a certain power level when measured at a distance of fifty feet from the antenna would then register one-fourth that power level at one hundred feet and one-sixteenth at two hundred feet. Radio waves can also diminish in intensity as they are absorbed or scattered by air, fog or objects.

An electromagnetic wave's basic properties may be manipulated to encode information within the wave. This process is called modulation. The amplitude of the wave may be varied as in AM radio, or the frequency of the wave may be varied as in FM radio. The frequency or amplitude of the continuous wave is changed in proportion to an imposed signal. The imposed signal is the information such as a radio, TV, or radar signal. RFR is generally of lower frequencies and lower energy levels than many other types of artificially generated electromagnetic energy.

Refer to the previous chart of the electronic spectrum provided as Figure 4.12-1. Specific ranges and segregation of frequencies for RFR are identified below.

RFR, in general 3 kHz to 300 GHz

AM Radio 550 - 1600 kHz

FM Radio, TV channels 2-13 30 - 300 MHZ

UHF Television 470 - 806 MHZ

Commercial Paging 35, 43, 152, 158, 454, 931 MHZ

Cellular Telephone 824-849 MHZ, 869-894 MHZ

Specialized Mobile Radio (SMR) "800 MHZ" (806-821/851-866 MHZ)

"900 MHZ" (896-901/935-941 MHZ)

Personal Communication Services (PCS) 901-941, 1850-1990 MHZ

#### **4.12.3.3 Ionizing and Non-ionizing Radiation**

Radiation is characterized by its effect upon absorption as either ionizing or non-ionizing radiation. Ionizing means that there is sufficient energy to change the chemical structure of the absorbing matter by removing one or more electrons, creating an electrically charged particle (ion). Non-ionizing means that there is not enough energy in the radiation to create ions. Instead, the energy is absorbed only as heat. Because of its low energy, RFR is non-ionizing radiation.

With their high frequencies and energies, X-rays, some gamma rays and radiation from nuclear processes are ionizing radiation. When ionizing radiation interacts with living structures, it can cause chemical bonds of molecules struck by high-energy particles to be broken. If the absorbing molecules are DNA or other genetic materials, cellular metabolism can be interfered with and the cell's ability to reproduce itself can be altered. Correlations have been made between the incidence of cancer and high rates of exposure to ionizing radiation (National Research Council, 1990).

Non-ionizing RFR does not directly alter molecular structure. When RFR is absorbed, it results in an increase in molecular movement. This is sensed as heat. RFR, which is low frequency and low-energy, produces relatively low amounts of heat in biological tissue. Non-ionizing radiation is not known to damage DNA in the manner that ionizing radiation does.

A useful concept to measure the effect of non-ionizing radiation is specific absorption rate (SAR). SAR is the measurement of power absorbed by whomever or whatever is being studied. It is the power deposited in tissue by the electromagnetic wave, measured in Watts per kilogram of body mass (W/kg).

Group / activity-specific training shall be given to each employee prior to work that includes a discussion of RF hazards and other safety information. In addition the group/activity training shall review emergency response measures and any other procedural information. This training shall be documented by the Group Leader / Department Manager.

#### **4.12.4 TRAINING**

Currently, there is no institutional training module for the Radio Frequency (RF) Radiation-Generating Devices Program. However, all affected populations are required to read this program and comply with the requirements discussed in the section.

#### 4.12.5 PERFORMANCE CHECKLISTS

**Group Leader / Department Manager shall:**

- ☐ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ☐ Review the safety training section for RF in this Manual.
- ☐ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ☐ Conduct and document group/activity-specific training for each employee prior to work that includes a discussion of RFR, hazard mitigation, and emergency procedures.
- ☐ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ☐ Assure that equipment and room where potentially high levels of RFR will be produced are marked and labeled in accordance with the guidelines in the ACGIH Handbook.
- ☐ Assure that all activities that include use of RF radiation-generating devices receive Readiness Review.

**Employees shall:**

- ☐ Review the safety training section for RF in this Manual.
- ☐ Receive activity or experiment-specific training prior to working with radioactive materials.
- ☐ Perform work in accordance with group Standard Operating Procedures (SOPs).

### **4.13 ULTRAVIOLET (UV) LIGHT –GENERATING DEVICES**

***Applicability Statement:** This section applies to Groups/Departments using devices that generate UV light.*

#### **4.13.1 REFERENCES**

American Conference of Governmental Industrial Hygienists (ACGIH) Handbook entitled “Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices”

ANSI/IEEE Standard C95.1, “Safe Levels With Respect to Human Exposure to UV Radiation”

#### **4.13.2 BACKGROUND**

Use of devices that generate UV light is an important part of several of the Laboratory’s research programs. The hazards associated with UV light are significant and demand an effective management program. This section describes the health physics protection mechanisms designed to ensure worker protection from UV light.

#### **4.13.3 PROGRAM INFORMATION**

Ames Laboratory follows the requirements listed in American Conference of Governmental Industrial Hygienists (ACGIH) Handbook entitled “Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices” and ANSI/IEEE Standard C95.1, “Safe Levels With Respect to Human Exposure to UV Radiation.” These documents, along with the information contained in this section of the Ames Laboratory Program Manual and the training module constitute the Laboratory’s written program.

##### **4.13.3.1 What is Ultraviolet Radiation?**

Ultraviolet radiation is the portion of the invisible light spectrum between approximately 100 and 400 nanometers (nm). The primary source of UV is the sun, but artificial sources include welder's flash, sunlamps or tanning parlors, high-intensity mercury vapor lamps used for night sports, special lamps used in infant care units, xenon arc lamps, and lasers.

Ultraviolet is composed of three segments, designated as A, B, and C. UV-C (below 280 nm) is filtered by the earth's ozone layer and does not reach earth. Because it never reaches us, UVC currently does not pose a threat. There is much evidence, however, that exposure to both UV-A and UV-B can have adverse short-term and long-term effects on your eyes and visual health.

##### **4.13.3.2 Possible Effects of UV**

The most common short-term effects of UV exposure are termed "snow blindness" and "welder's flash." Both of these conditions result from corneal exposure to excessive amounts of UV radiation over a short amount time. This is like a sunburn of the eye. The exposure can come from a welding arc or from long hours spent in snowy altitudes or the beach without proper eye protection. Symptoms include red eyes, a gritty or foreign sandy sensation, extreme light sensitivity, and tearing. Though painful, these symptoms are usually temporary and rarely cause

permanent damage. Long-term effects of UV radiation, on the other hand, are usually gradual and painless. Vision impairment can result from premature cataract formation due to the cumulative effects of UV exposure. It has been reported that 10 percent of cataract operations are necessitated by this type of UV exposure.

Long-term exposure to UV radiation has also been implicated in age-related macular degeneration. This condition affects 10 percent of the U.S. population over the age of 52, and increases to 33 percent in people over age 75. Age-related macular degeneration is the leading cause of vision loss in older Americans.

#### **4.13.3.3 Recommendations for Protection**

Here are some helpful tips from the American Optometric Association that can be used when selecting sunglasses.

Sunglasses should:

- block 99-100 percent of both UV-A and UV-B radiation;
- screen out 75 to 90 percent of visible light; and
- are perfectly matched in color and absorption, and are free of distortion and imperfections.

You should also wear clothing to cover areas of the body possibly exposed to UVR.

Group / activity-specific training shall be given to each employee prior to work that includes a discussion of UV hazards and other safety information. In addition the group/activity training shall review emergency response measures and any other procedural information. This training shall be documented by the Group Leader / Department Manager.

#### **4.13.4 TRAINING**

Currently, there is no institutional training module for UV Radiation-Generating Devices. However, it is imperative that supervisory personnel are aware of all sources of UV exposures and potential for adverse health affects and inform all personnel as to how to protect themselves. At a minimum, both supervisory personnel and research group members with potential to interact with sources of UV shall be required to read this program and comply with the safety requirements discussed in the section.

#### **4.13.5 PERFORMANCE CHECKLISTS**

**Group Leader / Department Manager** shall:

- ☐ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ☐ Review the UV training information in this Manual.
- ☐ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ☐ Conduct and document group/activity-specific training for each employee prior to work that includes a discussion of UVR, hazard mitigation, and emergency procedures.

- ☐ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ☐ Assure that equipment emitting potentially hazardous levels of UVR and laboratories are properly marked and labeled in accordance with guidelines given in the ACGIH.
- ☐ Assure that all activities that include work with UV radiation-generating devices receive Readiness Review.

**Employees shall:**

- ☐ Review the UV training information in this Manual.
- ☐ Receive activity/experiment-specific training prior to work with UV radiation-generating devices.
- ☐ Perform work in accordance with group Standard Operating Procedures (SOPs).

## 4.14 MAGNET SYTEMS

**Applicability Statement:** *This section applies to groups/departments that conduct research using magnet systems.*

### 4.14.1 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH) TLV booklet entitled “Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices”. Specifically, the section entitled “Non-Ionizing Radiation and Fields (pp. 152-156) addresses acceptable magnetic and electric field exposure levels for these systems.

### 4.14.2 BACKGROUND

Use of magnet systems is an important part of research conducted at Ames Laboratory. The hazards associated with high-powered magnets are significant and demand an effective management program. This section describes the designed to minimize employee exposures and therefore ensure worker protection from electric and magnetic fields.

### 4.14.3 PROGRAM INFORMATION

#### 4.14.3.1 Exposure Limits

The ACGIH TLV values and associated text are as follows:

##### 4.14.3.1.1 Static Magnetic Fields

These TLVs refer to static magnetic field flux densities to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. These values should be used as guides in the control of exposure to static magnetic fields and should not be regarded as fine lines between safe and dangerous levels.

Routine occupational exposures should not exceed 60 millitesla (mT), equivalent to 600 gauss (G), whole body or 600 mT (6,000 G) to the limbs on a daily, TWA basis [1 tesla (T) = 10,000 G]. Recommended ceiling values are 2 T for the whole body and 5 T for the limbs. Safety hazards may exist from the mechanical forces exerted by the magnetic field upon ferromagnetic tools and medical implants. Cardiac pacemaker and similar medical electronic devices wearers should not be exposed to field levels exceeding 0.5 mT (5 G). Adverse effects may also be produced at higher flux densities resulting from forces upon other implanted devices such as suture staples, aneurism clips, prostheses, etc. These TLVs are summarized in Table 1.

**TABLE 1. TLVs for Static Magnetic Fields**

	8-hour TWA	Ceiling
Whole body	60 mT	2 T
Limbs	600 mT	5 T
Medical electronic device wearers	—	0.5 mT

#### 4.14.3.1.2 Sub-Radiofrequency (30 kHz and below) and Magnetic Fields

These TLVs refer to the amplitude of the magnetic flux density (B) of sub-radiofrequency (sub-RF) magnetic fields in the frequency range of 30 kilohertz (kHz) and below to which it is believed that nearly all workers may be exposed repeatedly without adverse health effects. The magnetic field strengths in these TLVs are root-mean-square (rms) values. These values should be used as guides in the control of exposure to sub-radiofrequency magnetic fields and should not be regarded as fine lines between safe and dangerous levels.

Occupational exposures in the extremely-lowfrequency (ELF) range from 1 to 300 hertz (Hz) should not exceed the ceiling value given by the equation:

$$B_{\text{TLV}} = 60 / f$$

where:  $f$  = the frequency in Hz,  $B_{\text{TLV}}$  = the magnetic flux density in millitesla (mT).

For frequencies in the range of 300 Hz to 30 kHz (which includes the voice frequency [VF] band from 300 Hz to 3 kHz and the very-low-frequency [VLF] band from 3 to 30 kHz), occupational exposures should not exceed the ceiling value of 0.2 mT.

These ceiling values for frequencies of 300 Hz to 30 kHz are intended for both partial-body and whole-body exposures. For frequencies below 300 Hz, the TLV for exposure of the extremities can be increased by a factor of 10 for the hands and feet and by a factor of 5 for the arms and legs.

The magnetic flux density of 60 mT/f at 60 Hz corresponds to a maximum permissible flux density of 1 mT. At 30 kHz, the TLV is 0.2 mT, which corresponds to a magnetic field intensity of 160 A/m.

Contact currents from touching ungrounded objects that have acquired an induced electrical charge in a strong sub-RF magnetic field should not exceed the following point contact levels to avoid startle responses or severe electrical shocks:

- A. 1.0 milliampere (mA) at frequencies from 1 Hz to 2.5 kHz.
- B.  $0.4f$  mA at frequencies from 2.5 to 30 kHz, where  $f$  is the frequency expressed in kHz.

#### 4.14.3.1.3 Sub-Radiofrequency (30 kHz and below) and Static Electric Fields

These TLVs refer to the maximum unprotected workplace field strengths of sub-radiofrequency electric fields (30 kHz and below) and static electric fields that represent conditions under which it is believed that nearly all workers may be exposed repeatedly without adverse health effects. The electric field intensities in these TLVs are root-mean-square (rms) values. The values should be used as guides in the control of exposure and, due to individual susceptibility, should not be regarded as a fine line between safe and dangerous levels. The electric field strengths stated in these TLVs refer to the field levels present in air, away from the surfaces of conductors (where spark discharges and contact currents may pose significant hazards).

Occupational exposures should not exceed a field strength of 25 kilovolts per meter (kV/m) from 0 hertz (Hz) (direct current [DC]) to 100 Hz. For frequencies in the range of 100 to 4 kilohertz (kHz), the ceiling value is given by:

$$E_{\text{TLV}} = 2.5 \times 10^6 / f$$

where:  $f$  = the frequency in Hz;  $E_{\text{TLV}}$  = the electric field strength in volts per meter (V/m).

A value of 625 V/m is the ceiling value for frequencies from 4 to 30 kHz. These ceiling values 0 to 30 kHz are intended for both partial-body and whole-body exposures.

**Notes:**

1. These TLVs are based on limiting currents on the body surface and induced internal currents to levels below those that are believed to produce adverse health effects. Certain biological effects have been demonstrated in laboratory studies at electric field strengths below those permitted in the TLV; however, there is no convincing evidence at the present time that occupational exposure to these field levels leads to adverse health effects.

Modifications of the TLVs will be made if warranted by new information. At this time, there is insufficient information on human responses and possible health effects of electric fields in the frequency range of 0 to 30 kHz to permit the establishment of a TLV for time-weighted average exposures.

2. Field strengths greater than approximately 5 to 7 kV/m can produce a wide range of safety hazards such as startle reactions associated with spark discharges and contact currents from ungrounded conductors within the field. In addition, safety hazards associated with combustion, ignition of flammable materials, and electro-explosive devices may exist when a high-intensity electric field is present. Care should be taken to eliminate underground objects, to ground such objects, or to use insulated gloves when ungrounded objects must be handled. Prudence dictates the use of protective devices (e.g., suits, gloves, and insulation) in all fields exceeding 15 kV/m.
3. For workers with cardiac pacemakers, the TLV may not protect against electromagnetic interference with pacemaker function. Some models of cardiac pacemakers have been shown to be susceptible to interference by power frequency (50/60 Hz) electric fields as low as 2 kV/m. It is recommended that, lacking specific information on electromagnetic interference from the manufacturer, the exposure of pacemaker and medical electronic device wearers should be maintained at or below 1 kV/m.

#### **4.14.3.2 Signage & Other Types of Notifications**

As stated previously, certain segments of the population (e.g. people with pacemakers) may be susceptible to 5 Gauss fields. To address that potential hazard, employee notification is

paramount. There are many methods of notification including signage, barricades, floor markings. Examples are given below:



Picture 1. Sample magnetic field warning sign on laboratory door denoting 5 Gauss line.



Picture 2. Sample magnetic field warning sign on unit denoting 5 Gauss line.



Picture 3. Warning sign on stanchions and floor markings denoting 5 and 10 Gauss lines.

It shall be the Group Leaders responsibility to determine the best means of employee notification in their respective research areas. ESH&A can provide assistance in determining the most effective means of employee notifications and can custom make signage upon request.

#### **4.14.3.3 Training**

Currently, there is no institutional training module for the operation of magnets or magnet systems. Group or activity-specific training shall be given to each employee prior to work that includes a discussion of magnetic fields and other pertinent safety information. Verification of group or activity-specific training is conducted during Readiness Review.

#### **4.14.5 PERFORMANCE CHECKLISTS**

**Group Leader / Department Manager** shall:

- ☐ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ☐ Review the safety training presented in this Manual on magnets.
- ☐ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ☐ Conduct and document group/activity-specific training for each employee prior to work that includes a discussion of magnets with potential hazards and controls.
- ☐ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ☐ Assure that equipment and laboratories are properly labeled so occupants are notified of 5 Gauss fields.

**Employees** shall:

- ☐ Review the safety information on magnets contained in this section of the Manual.
- ☐ Receive group/activity-specific training prior to working with magnet systems.
- ☐ Perform work in accordance with group Standard Operating Procedures (SOPs).

**Environment, Safety, Health and Assurance** shall:

- ☐ Provide consultations upon request on issues related to management of potential hazards associated with magnet systems including signage and other forms of employee notifications.